SECTION 9.0 - DISPOSAL SITE MANAGEMENT PLAN

9.0 DRAFT DISPOSAL SITE MANAGEMENT PLAN

The potential for negative impacts associated with the disposal of UDM requires ongoing monitoring and management to ensure the integrity of the environment in which the material is placed. This section describes monitoring and management measures to be implemented to confirm compliance with permit standards and long-term sequestering of UDM for the marine environments, to minimize any potential pollution pathways associated with the implementation of the preferred alternative disposal sites.

9.1 CAD SITE MONITORING

9.1.1 Monitoring Objectives

Evaluation of the environmental impacts of dredged material disposal in New Bedford/Fairhaven Harbor is best addressed through the use of a tiered monitoring strategy. With the exception of a few aquatic dredged material disposal monitoring programs including New England (DAMOS), Washington (PSDDA), and New York, most have suffered from a lack of clearly defined objectives, testable hypotheses, careful sampling design, statistical rigor, and conclusive results. The tiered monitoring approach is based upon addressing key questions and/or formal hypotheses at a series of predetermined levels to ensure compliance with objectives and permitting requirements. The decision criteria are used to create a framework for defensible management decisions and eliminate the tendency for a "shotgun" approach to data collection.

The tiered monitoring approach is dependent on rapid data return and analysis to identify and respond effectively to any detected changes in physical, chemical, or biological condition within the disposal site. The monitoring program will incorporate data at multiple temporal and spatial scales and of various media (e.g., video, photographs, maps); it is critical that these data be quickly integrated into digital and written products. Utilization of state-of-the-art decision-making tools such as Geographic Information Systems (GIS) will facilitate the rapid dissemination of spatially-explicit information for decision-making by resource managers.

The New Bedford/Fairhaven disposal site management/monitoring plan addresses both the engineering aspects of the disposal and capping operations and the environmental impacts of the project, through the following major objectives:

- Establish an environmental baseline prior to dredging and disposal of the dredged material,
- Establish acceptance guidelines for Water Quality Standards during dredging and disposal operations,
- Evaluate the short-term effects of disposal on benthic habitat quality and marine resources,
- Assess the engineering effectiveness and integrity of the CAD approach cap, and
- Evaluate the effectiveness of the confined disposal method and cap for preventing long-term impacts on biological resources.

Federal guidelines for laboratory testing of dredged material prior to its discharge in open water require that reference sediment be used as a basis for comparison. Reference sediment typically is collected in areas outside the influence of previous disposal operations at a dredged material disposal site, but near enough to the disposal site that the reference sediment is subjected to the same water quality and hydrodynamic influences. The laboratory test results for the proposed dredged material are compared to the reference sediment test results to evaluate the likelihood of adverse environmental impacts. Likewise, in environmental monitoring of dredged material disposal impacts in the field, results from reference areas are used in a comparative way to evaluate environmental impacts at the disposal site. Thus, use of reference sediment and/or reference areas is key to the evaluation of dredged material disposal impacts. The following information will provide the basis for the monitoring section of the management plan. These recommendations will be modified in response to the public and agency comments, and to accommodate additional site-specific data yet to be collected.

9.1.2 Baseline Studies

Although the dredged material disposal siting process in New Bedford/Fairhaven Harbor incorporated vast amounts of information about the physical and chemical properties of seawater and sediments at the proposed disposal sites, much of this information was either dated, spatially insufficient to provide site-specific details, or lacking temporal resolution. Collection of additional information prior to usage of the designated site is necessary before proceeding to dredging or disposal activities. The baseline study should include the collection of additional data to characterize existing (i.e., pre-disposal) conditions at the designated site, including current velocity, background suspended sediment concentration, and water quality. The measurement of several of the parameters will continue during dredging and disposal activities, but it is critical to characterize existing ambient conditions prior to the disturbance to provide a comparison with later measurements.

9.1.2.1 Wave, Current, and Tidal Measurement

Circulation patterns and sediment transport in New Bedford/Fairhaven Harbor have not been well characterized due to the limited number of oceanographic studies. In order to develop an understanding of the physical processes influencing the stability of sediments at disposal sites, monitoring of current flow dynamics using instrument deployments is required. The major objective of monitoring activities will be to acquire site-specific data on waves, near-bottom tidal currents, and sediment resuspension within the disposal site. In addition, vertical current profile measurements are necessary as input variables into computer models (i.e., STFATE and LTFATE) to predict the fate of dredged material during disposal operations. The collected data will be used to evaluate and predict the potential for dredged material resuspension and transport under typical conditions, as well as during storm events. Measurement of critical site-specific data may also help determine the potential for sediment resuspension as a result of propeller wash from passing vessels, surface waves, and storm events.

The suggested approach is to deploy a bottom-mounted instrument array from a surface vessel, to be left in place on the seafloor at a selected location within the disposal site. The use acoustic Doppler current profilers (ADCP) for several days during a maximum tidal phase (spring tides) will provide needed information characterizing local hydrodynamic conditions at the disposal site. It is suggested that one of the ADCPs be upward-looking to provide a profile of current speed and direction in the overlying water column. A second ADCP could be used to measure tidal current speed and direction within one meter of the bottom. The equipment can be deployed with no surface buoy and an acoustically released retrieval mechanism to reduce potential fouling with lobster trawls or anchor lines, although there is a low probability of disturbance to the instruments since fishing activity within New Bedford/Fairhaven Harbor is minimal.

Accurate measurement of tidal height is also necessary since it can be used as input to nearshore circulation and tidal current amplitude predictions. Presently all tidal measurements in New Bedford/Fairhaven Harbor are based on predicted estimates from the Woods Hole tidal gauge, the nearest permanent NOS/NOAA measurement station. More accurate tidal height measurements in New Bedford/Fairhaven Harbor are possible by deploying high resolution pressure sensors at one or more locations to provide vertical control and record tidal height measurements over a 28-day cycle. This information could then be used to predict the tidal component of currents and be correlated to long-term current data gathered from vertical profiles or bottom-mounted current measurements.

9.1.2.2 Water Quality Monitoring

To provide an accurate assessment of water quality impacts as a result of dredged material disposal, a detailed characterization of baseline conditions at the disposal site should be undertaken using a monitoring plan that conducts sampling at multiple time scales. The greatest potential change to background water column conditions is likely to occur during periods of high suspended sediment loads immediately following barge disposal. It is recommended that monitoring of water quality conditions be conducted at the time of disposal using both shipboard and stationary sampling instruments.

The data collected at the disposal site will also need to be compared with data collected at one or more nearby reference sites to determine if any detected changes are a result of localized or regional patterns. Water quality measurements should include vertical profiling of total suspended solids, dissolved oxygen, salinity, and temperature. These variables provide sufficient information to gauge the presence of low dissolved oxygen levels (hypoxia or anoxia), the development of a thermocline, and/or localized disturbances that may influence water quality.

9.1.3 Water Quality Standards

The development of water quality standards prior to dredging and disposal actives will provide target baseline conditions, which are not to be exceeded during operations. Failure to meet these standards will trigger mitigation responses to ensure that water quality conditions and marine resources within New Bedford/Fairhaven Harbor are not compromised. The following criteria are recommended:

> The boundary of the mixing zone for dredging and disposal of project sediments should be located 300 ft downcurrent from the operations. Both acute and chronic water quality criteria shall be met at the mixing zone boundary, with the acute criteria to be met at all times. Acute criteria are defined

as the one hour average concentration, which should not be exceeded more than once every three years on average. Chronic criteria are defined as the four day average concentration which should not be exceeded more than once every three years, except for the PCB chronic criterion which is a 24 hour limit of exposure.

Exceedence of the water quality criteria shall be attributed to operations when the sample concentration down current from the project operations exceeds the particular standard and the sample concentration is 30% higher than the reference sample. Real-time measurements of DO should be used to measure compliance and failure to meet the standards when there is a statistical difference at a 95% confidence interval between the mean of the reference sample and the mean of the down-current sample. If the samples exceed the water quality standard and this effect is attributed to project operations than repeat samples should be analyzed for TSS and the parameter(s) of concern within 24 hours.

If two consecutive water samples fail to meet acute water quality criteria the project operants can take the following actions to limit such exceedences: implement pre-approved contingency plan or cease all activities until a suitable alternative is provided.

If two consecutive water samples fail to meet acute water quality criteria than the following actions shall be implemented: work may continue if chronic bioassay tests are conducted within 24 hours or an approved mitigation effort is implemented.

In the event that compliance with the water quality standards is not maintained, the following bioassay and bioaccumulation tests are recommended:

Conduct bioassays to monitor disposal of dredged material. Collect water samples during first two days of monitoring, four to six hours after disposal 300 yards downcurrrent from the cell. Conduct two bioassay tests: sea urchin (*Arbacia punctulata*) fertilization and 7 day shrimp (*Mysidopsis bahia*) chronic endpoint studies to assess the biological effects of pollutants that may be present.

Conduct a bioaccumulation study to assess the long-term impacts of contaminants on blue mussels (*Mytilus edulis*). Deploy caged mussels for at least 60 days at mid water column depth 300 yards from the disposal cell. Analyze mussel tissues for the metals arsenic, cadmium, lead, mercury, and organics (PCBs and PAHs).

9.1.4 Monitoring of Short-term Water Quality Impacts

The proposed tiered approach to monitoring dredged material disposal impacts in New Bedford/Fairhaven Harbor has been summarized in a series of "decision tree" flow charts, which are presented and discussed in the following sections. Each flow chart is organized around a null hypothesis. Different "tiers" within the flow chart present a series of questions and "yes/no" decision points used to address this null hypothesis. Tier 1 generally represents the minimum or "routine" level of monitoring. If the monitoring at this level indicates an absence of adverse environmental impacts, then there typically is no need to take management action and proceed to higher levels (involving more extensive and costly monitoring). However, the decision tree is structured such that indications of adverse effects at lower levels will trigger management actions involving more thorough examination of the impacts at higher levels. The following sections refer to the decision tree flow chart shown in Figure 9-1, which is designed to test the following null hypothesis: "Dredging and disposal activities have no short-term impact on water quality."

9.1.4.1 Tier One: Acute and Chronic Water Quality Standards

Box 1.1: "Assess Water Quality in Mixing Zone"

The assessment of short-term (hours to days) water quality impacts from disposal activities will require standardized and frequent monitoring during disposal events. The Tier 1 monitoring activities shown in Figure 9-1 also are required to verify compliance to the water quality standards. There was an intensive water quality monitoring effort associated with the placement into CAD cells of material generated by the Boston Harbor dredging project. This experience showed that exceedances of water quality criteria during disposal operations were rare. The proposed plan for New Bedford/Fairhaven Harbor, therefore, incorporates the water quality monitoring deemed necessary to verify compliance while avoiding unnecessary data collection. The following standards are recommended:

- The mixing zone for disposal of project sediments should be located 300 ft downcurrent from the activity.

- To ensure that water quality standards are maintained, samples should be taken within the downcurrent turbidity maximum; use of instrumentation capable of real-time display of the plume extent is recommended. Use of a transmissometer can provide a depth profile of light transmittance or turbidity values. This instrument provides the capability to generate turbidity contour plots showing the areal extent and concentration.

- Suspended solids should not exceed 25mg/l over background levels at 25 m from the operation when ambient levels are lower than 100 mg/l.

- Turbidity should not exceed ambient levels by more than 30% at 25m from the operation.

- Plume samples should be taken at 0.5 and 1.0 hours, and four and six hours after the disposal at a location 300 feet downcurrent from the cell. Samples should be obtained from within 3 feet of the harbor bottom and from the mid-water column. These samples can either be combined or depth integrated. The first set of samples will be used to determine if acute criteria are met and the second set to determine whether chronic criteria are met.

- Acceptable locations for reference samples include a point 1000 ft upcurrent of the disposal cell, a point 300 ft downcurrent from the disposal cell prior to disposal, or some other pre-approved location.

- Water quality monitoring and analysis should be conducted during the first five days of disposal.

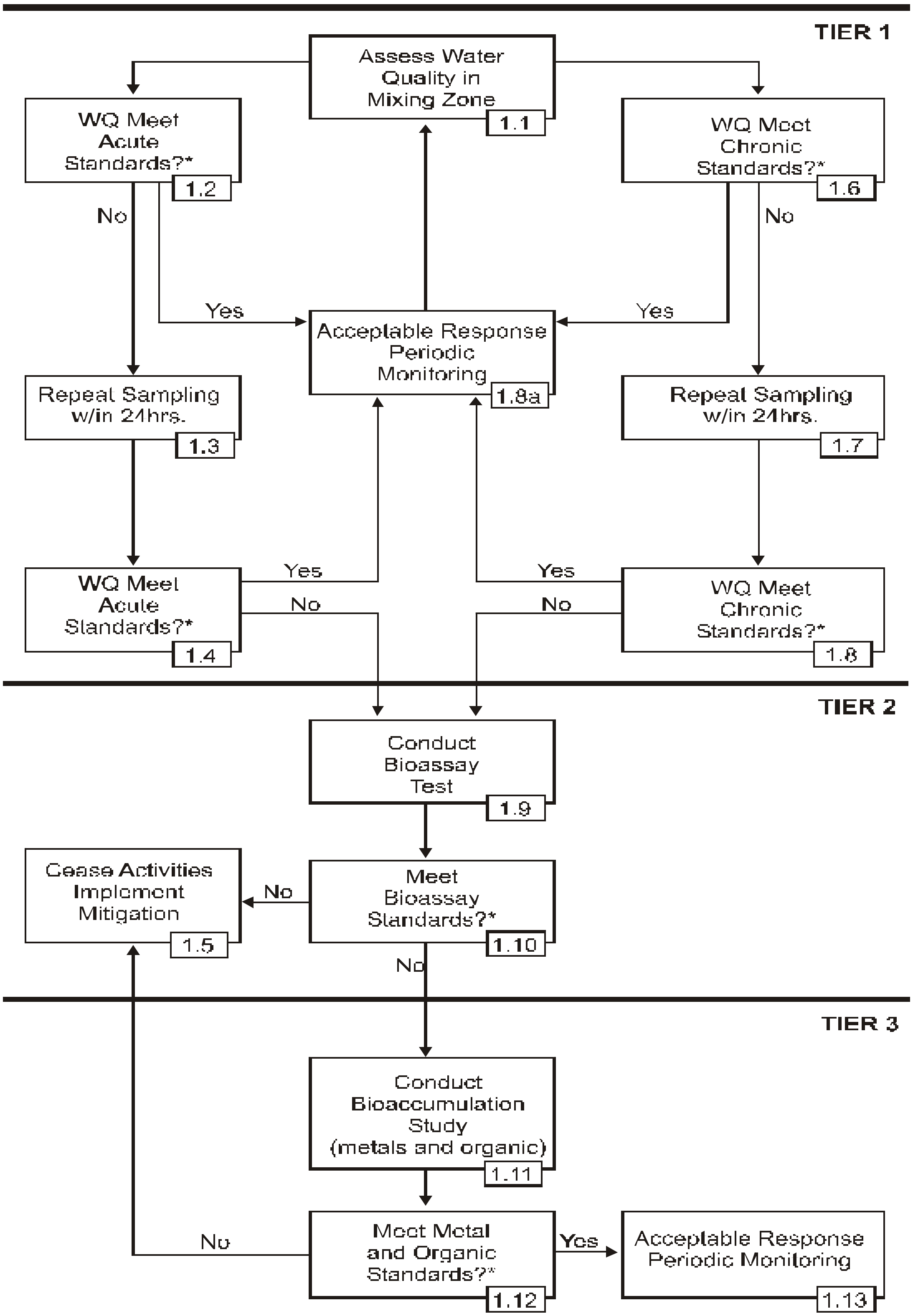

Figure 9-1: H_o1: Dredging or Disposal Activities have no Short-Term Impact on Water Quality.

Box 1.2 and Box 1.6 "Water Quality Conditions meet Acute and Chronic Standards"
Acute criteria are defined as the one hour average concentration which should not be exceeded more than once every three years on average. Acute criteria should be met within the mixing zone at all times. Chronic criteria are defined as the 4 day average concentration which should not be exceeded more than once every three years, except that the PCB chronic criterion is a 24 hr limit of exposure.

Box 1.3 and Box 1.7 "Repeat sampling within 24 hrs."
If samples fail to meet water quality standards, than repeat samples should be obtained within 24 hrs under similar conditions. The repeat samples should be analyzed for the parameter(s) of concern and TSS.

Box 1.4: "Water Quality Conditions meet Acute Standards"
If two consecutive water samples fail to meet the acute water quality criteria than either a pre-approved mitigation measure must be implemented or all disposal activities should cease within the effective area till further notice.

Box 1.8 : "Water Quality Conditions meet Chronic Standards"
If two consecutive water samples fail to meet chronic water quality criteria the following action should be implemented: work may continue if chronic biossay tests are conducted within 24 hours or mitigation controls are implemented.

9.1.4.2 Tier Two: Bioassay Testing

Box 1.9 "Conduct Bioassay Test"
Conduct sea urchin fertilization test and seven-day *Mysidopsis bathia* (shrimp) test according to EPA protocols for chronic endpoints. The results of the biological test should be considered as more significant than the water quality criteria in determining any operational mitigation measures to be required.

Box 1.10 "Meet Bioassay Standards"
Failure to meet Chronic bioassay standards will require all disposal activities to cease or implementing pre-approved mitigation controls

9.1.4.3 Tier Three: Bioaccumulation Testing

Box 1.11 "Conduct Bioaccumulation Study"
Should continued concern over water quality impacts result from the first two tiers, conduct a bioaccumulation study for the contaminants of concern by deploying caged blue mussels (*Mytilus edulis*) at mid-water column depth within approximately 1000 ft of the disposal area for at least 60 days.

Box 1.12 "Meet Metal and Organic Standards"
Failure to meet bioaccumulation standards will require all disposal activities to cease or implementing pre-approved mitigation controls.

Box 1.13 "Acceptable Response, Periodic Monitoring"
Meeting the bioaccumulation standards will be considered an acceptable response. Disposal can continue with periodic water quality monitoring during events.

9.1.5 Verify Successful Placement of Dredged Material and Cap Material

The following sections refer to the decision tree flow chart shown in Figure 9-2, which is designed to test the following null hypothesis: "Dredged material and cap material have been successfully placed according to design specifications."

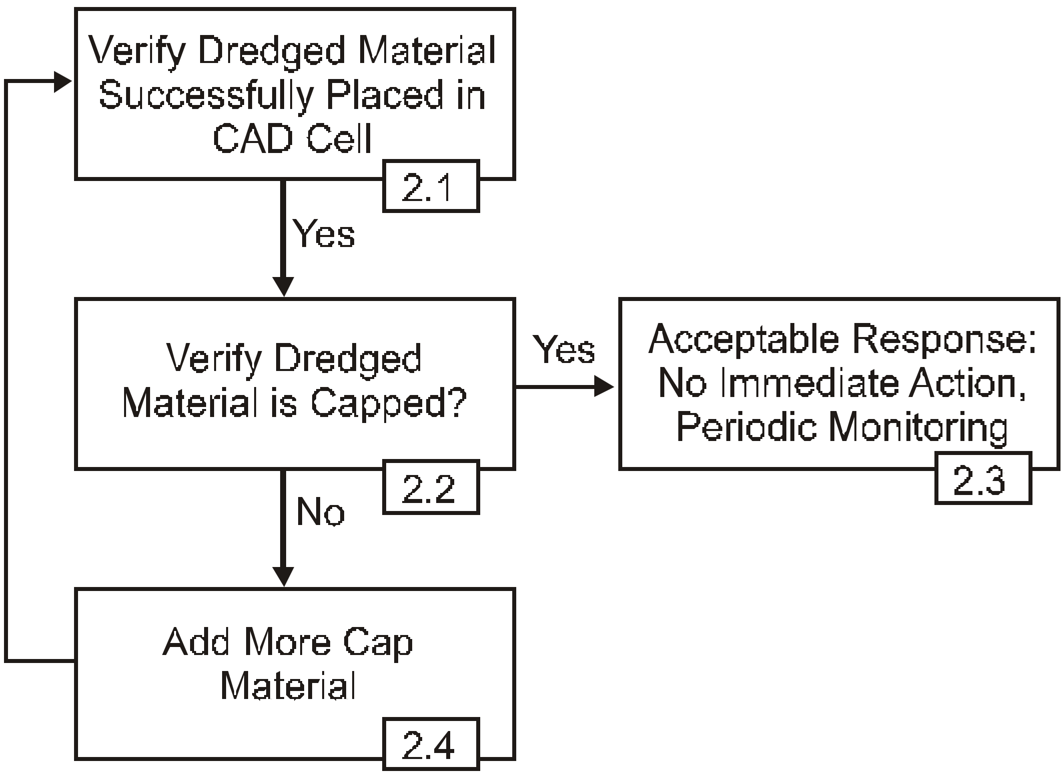

Figure 9-2: H_o2: Dredged material and cap material have been successfully placed according to design specifications.

9.1.5.1 Tier I: Operational Processes

Box 2.1 "Verify Dredged Material Successfully Placed"
Monitoring is required to verify that dredged material is placed accurately within a disposal site or CAD cell. The position of all vessels (e.g., barges, scows, dredges) used for placing material within a CAD cell must be controlled using a navigation system capable of achieving horizontal accuracy on the order of less than 10 m (e.g., differential GPS or microwave system). In addition, it is recommended that the position of all disposal vessels be recorded during loading at the dredging site, transit, and placement of the material at the disposal location using an automated "black box" surveillance system (e.g., ADISS system or equivalent). The combination of high-resolution navigation systems and automated surveillance of vessel position will help to ensure that material is placed accurately during the disposal operations.

Box 2.2 "Verify Placement of the Cap"
Similar to the dredged material placement operations, the position of all vessels (e.g., barges, scows, dredges) used for placing cap material within a CAD cell must be controlled using a navigation system capable of achieving horizontal accuracy on the order of less than 10 m (e.g., differential GPS or microwave system). Vessel position should be recorded using an automatic surveillance system. Following cap placement, physical monitoring is conducted to verify complete coverage of the dredged material. This evaluation typically involves conducting a high-resolution bathymetric survey in combination with sub-bottom profiling to verify depth of the cap material. Sediment cores might also be collected to measure cap thickness at individual points. A minimum average thickness of cap material should be specified (typically 1 meter), and the postcap monitoring should serve to verify whether or not this goal has been attained.

Box 2.4 "Add More Cap Material"
If the dredged material is insufficiently covered with capping material, further capping operations are necessary until the specified average cap thickness is achieved. Once the recapping has been completed, the disposal site should be re-surveyed to verify the cap thickness. If the cap thickness is found to be sufficient, no further operational monitoring is deemed necessary (Box 2.3).

9.1.6 Verify Isolation of Sediment Contaminants

The operational monitoring described above is used to verify successful placement of the cap according to design specifications. Additional monitoring is necessary to verify that the in-place cap is effective in isolating chemical contaminants known to occur at elevated levels in the underlying dredged material. The following sections refer to the decision tree flow chart shown in Figure 9-3, which is designed to test the following null hypothesis: "Capping has isolated sediment contaminants effectively."

9.1.6.1 Tier I: Surface Sediment Chemical Analysis

Box 3.1 " Collect Surface Sediments for Chemical Analysis"
Sediments comprising the surface of the cap are collected using a grab sampler and analyzed for the chemical contaminants known to be present at elevated levels in the underlying dredged material. The chemical concentrations in the surface of the cap are compared to those found in nearby reference areas (Box 3.2). If the concentrations are not significantly higher than those in the reference areas, it is assumed that the cap is effectively isolating the contaminants. Chemical analysis of the surface sediments should occur at regular intervals to ensure continued effectiveness of the cap through time (Box 3.3). Significant elevations above reference values indicate possible migration of the chemicals through the cap. Such results would trigger Tier 2 monitoring involving further sampling to ascertain the source of the contamination.

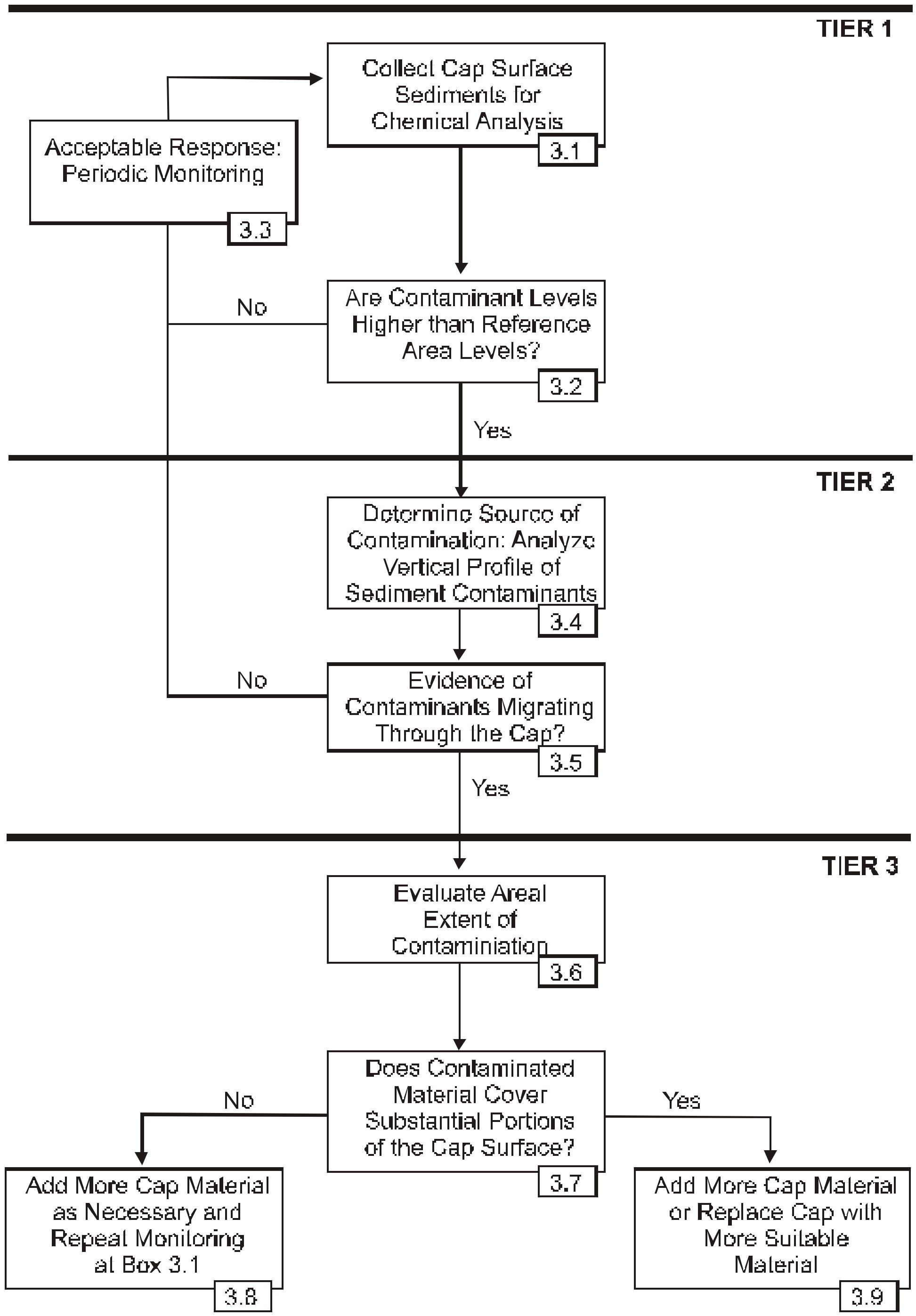

Figure 9-3: H_o3: Capping has Isolated Sediment Contaminants Effectively.

9.1.6.2 Tier II: Vertical Sediment Chemical Profiling

Box 3.4 "Determine Source of Contamination: Analyze Vertical Profile of Sediment Contaminants"
If there are contaminants present in the surface sediments of the cap at significant elevations above reference area levels, it is likely that the contaminated material has not been from sufficiently contained below the cap. Sediment core samples should be collected; these cores should be long enough to encompass both the cap material and the underlying dredged material. Chemical analysis of the sediment at discrete intervals within each core can be used to evaluate whether there are any vertical concentration gradients serving to implicate the underlying dredged material as the contaminant source.

Box 3.5 "Evidence of Contaminants Present Above the Cap?"
If the cores indicate there is contaminated material at the surface of the cell that originated from below the cap, it is possible that the cap not functioning as designed. The extent of the cap failure should be investigated further under Tier 3.

9.1.6.3 Tier III: Evaluate Extent of Cap Failure

Box 3.6: "Evaluate Areal Extent of Contamination"
Using the methods to establish cap presence (Figure 9-2) along with the coring data from above, the areal extent of the contaminated sediments should be measured to establish the areas most in need of additional cap material. Results from this study may indicate whether new material has been deposited on the site, an errant disposal event occurred, or large-scale failure of the cap occurred.

Box 3.7 "Does Contaminated Material Cover Substantial Portions of the Cap"
If the survey data collected above indicates that contaminated material has migrated through the cap in substantial portions of the disposal site, mitigation efforts are considered necessary to prevent further bioavailability of contaminants.

Boxes 3.8 and 3.9 "Add More Cap Material or Replace Cap with more Suitable Material"
The existing cap will need to be enhanced, based upon the identified origin of the cap failure. For example, the cap may need to be enhanced with sediment having a coarser grain size, which is less prone to erosion. It may also be necessary to increase the thickness of the cap material to provide a more effective barrier and greater insurance against future cap failures.

9.1.7 Long-term Impact on Biological Resources

9.1.7.1 Tier I: Benthic Recolonization of the Placed Material

The following sections refer to the decision tree flow chart shown in Figure 9-4, which is designed to test the following null hypothesis: "Dredging or disposal activities have no long-term adverse impacts on biological resources." Tier 1 of the flowchart addresses potential impacts to benthic infauna, while Tiers 2 and 3 address impacts to fisheries (Figure 9-4).

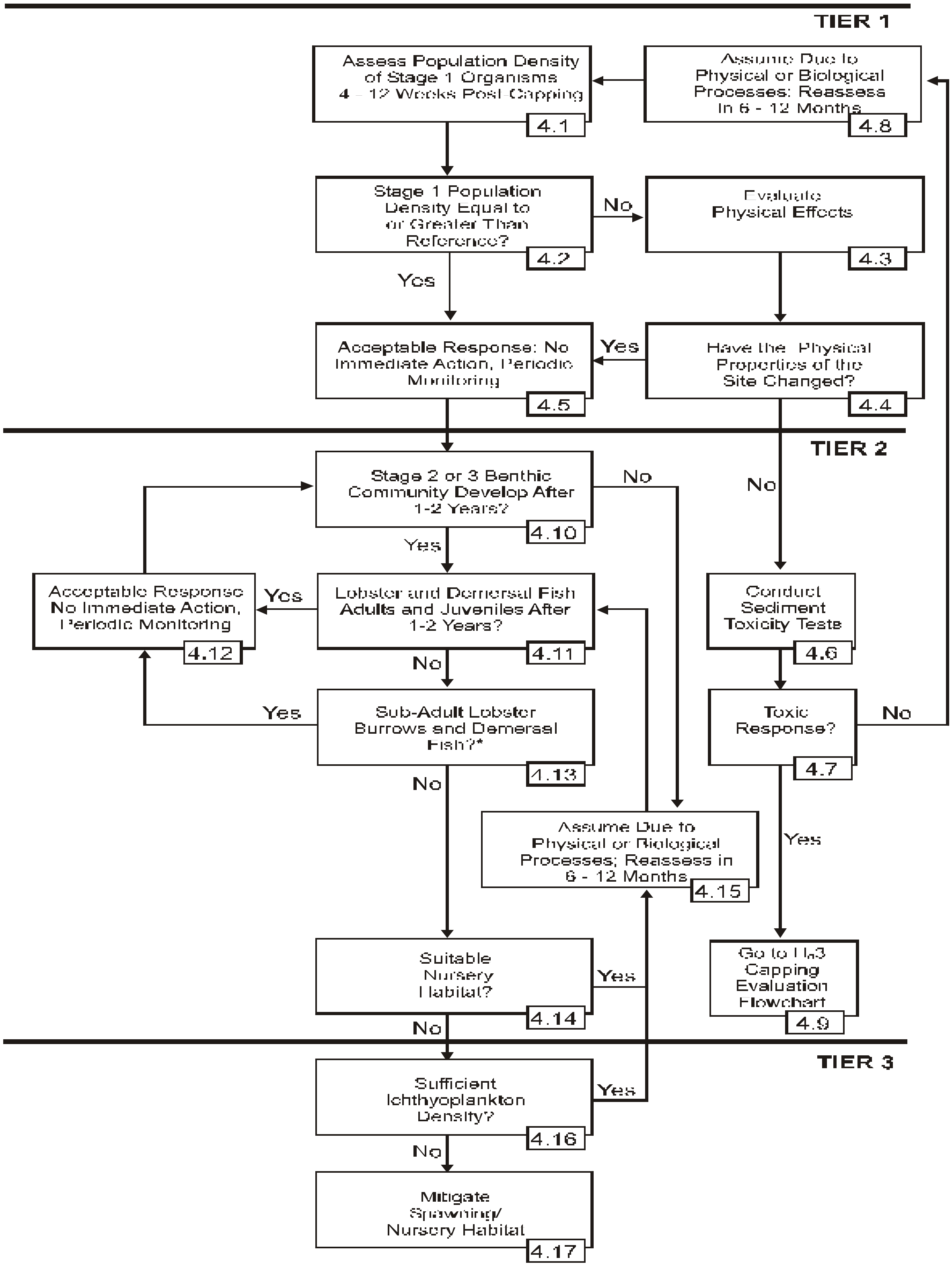

Figure 9-4: H_o4: Disposal/Capping Have No Long-Term Adverse Impacts on Biological Resources.

Box 4.1 : Assess Population Density of Stage 1 Organisms”

Uncontaminated, fine-grained sediment (e.g., dredged material or cap material) placed on the seafloor represents a clean, open substrate suitable for colonization by both adult and larval benthic organisms. Extensive past experience has demonstrated that benthic organisms colonize soft bottoms following a predictable pattern or successional sequence. Typically, the new sediment is populated first by an assemblage of pioneering or opportunistic species. This "Stage I" assemblage is usually comprised of small, tube-dwelling marine worms (polychaetes) which thrive at the sediment surface within days to weeks of material placement. With time (weeks to months), other benthic organisms which live at and a few centimeters below the surface begin to appear. This transitional, "Stage II" community may be comprised of small, shallow-dwelling bivalves and amphipods. Ultimately (months to years), the successional sequence leads to a "climax" or "equilibrium" community dominated by larger-bodied organisms which live and feed at depth within the sediment. This "Stage III" community is typically comprised of organisms which orient themselves in a head-down position and feed by ingesting the fine-grained sediment; these "deposit feeders" extract the organic matter and eject their waste (sediment and feces) at the sediment surface.

The feeding and burrowing activities of benthic infauna act to mix and thus enhance aeration of the sediment through a process called bioturbation. A mature, healthy soft-bottom benthic community typically is comprised of a diverse mixture of both surface-dwelling, Stage I and Stage II organisms and larger-bodied, deeper-dwelling Stage III organisms.

Since Stage I organisms are expected to be the initial colonizers of a newly-placed deposit of dredged material or cap material, Box 4.1 of Figure 9-4 involves assessing the population density of these organisms following the completion of capping operations. The Stage I population densities can be assessed through traditional grab sampling followed by taxonomic analysis of the benthic community, or by using a sediment-profile camera to obtain a vertical cross-section image of the sediment surface and associated organisms.

Box 4.2 “Stage 1 Population Density Equal to or Greater than Reference Area(s)”

The densities of surface-dwelling, Stage I polychaetes at the disposal site should be compared with densities at one or more reference stations located outside the designated boundaries of the disposal site. The selection of reference areas should include the following factors: similar sediment type as the disposal site cap, comparable water depths and water quality conditions, and a benthic and fisheries community structure similar to that at the disposal site prior to activities. Based on the standard benthic successional model for soft-bottom communities, it is expected that Stage 1 population densities at the disposal site will be equal to or higher than in the undisturbed reference areas within a few weeks of dredged material or cap material placement. If this condition is found, it indicates an acceptable response (Box 4.5). Monitoring at regular intervals (i.e., every 6 to 12 months) should continue to ascertain that the successional sequence proceeds to later, more advanced stages (see Tier 2).

Box 4.3 “Evaluate Physical Effects”

The detection of anomalous rates of colonization at the disposal site are typically attributed to physical or chemical properties of the dredged material or cap material.

Box 4.4 "Have the Physical Properties of the Site Changed?"

Sediment erosion and scour or differences in sediment material may cause anomalous recruitment patterns at the disposal site that may disrupt larval colonization.

Box 4.5 "Acceptable Response: No Immediate Action Necessary, Periodic Monitoring"

If the anomalous recolonization is due to a physical event, no immediate mitigation is warranted.

9.1.7.2 Tier II: Recovered Adult and Juvenile Marine Resources

Box 4.6 "Conduct Toxicity Tests"

If the anomalous recolonization pattern is not due to a physical event, testing of the sediment using the 10-day amphipod test is recommended to determine whether the anomaly is due to sediment toxicity (Box 4.7).

Box 4.8 "Assume Due to Physical or Biological Processes"

If the toxicity test shows an absence of sediment toxicity, the anomalous benthic results are most likely due to natural environmental conditions. The Stage I benthic recolonization status should be re-assessed in 6 to 12 months.

Box 4.9 " Go to $H_0$3 Disposal Evaluation Flowchart (Figure 9-3)"

If the toxicity test shows a toxic response, there may be a problem with the containment of the contaminated dredged material. The H_o3 (Effective Sediment Isolation) Flow Chart must be re-visited.

Box 4.10 "Stage 2 or 3 Benthic Community Develops after 1 Year"

As previously indicated, experience has shown that benthic succession on newly placed dredged material or cap material will result in the establishment of a more mature (i.e., Stage 2 or 3) benthic community within 1 to 2 years. Using either traditional grab sampling and taxonomic analysis or sediment-profile imaging, the benthic community can be compared to the reference area to evaluate longer-term recovery.

Box 4.11 "Lobster and Demersal Fish Adults and Juveniles after 1 Year"

Disposal activities are usually scheduled during winter and early-spring to avoid impacts to reproduction and recruitment dynamics of marine and invertebrate species. Establishment of a healthy, mature (i.e., Stage III) benthic community traditionally has been used as an indicator of acceptable recovery following dredged material or cap placement. Direct sampling of the fisheries at the disposal site also can be used to evaluate potential long-term impact. These data need to be collected over several seasons and analyzed with caution due to the temporally and spatially variable nature of fisheries data.

Box 4.12 "Acceptable Response: No Immediate Action, Periodic Monitoring"

The presence of both an advanced benthic community (Stages 2 and/or 3), as well as benthic fisheries (demersal fish and commercially valuable crustaceans like lobster) would suggest no long-term adverse impact from the disposal or cap placement activities.

Box 4.13 "Sub-adult Lobster Burrows and Juvenile Fish"

If the lobster and demersal fisheries data show a paucity of numbers, additional information on different life stages of these species can be collected.

Box 4.14 "Suitable Nursery Habitat"

The lack of juvenile fish might indicate that the habitat at the disposal site is no longer productive as a fisheries resource. This information would trigger more evaluation in Tier 3.

Box 4.15 "Assume Due to Physical or Biological Processes"

If the juvenile fish data indicate acceptable nursery habitat, the lack of both adult and juvenile fisheries at the site may be due to natural environmental processes, and additional data should be collected within a year, potentially during a different sampling season.

9.1.7.3 Tier III: Recovered Spawning and Nursery Habitat for Marine Resources

Box 4.16 "Sufficient Icthyoplankton Density"

An icthyoplankton survey would help to evaluate the suitability of the disposal site as an acceptable spawning and nursery habitat for benthic fisheries.

Box 4.17 "Mitigate Spawning/Nursery Habitat"

If all of the data collected indicate that the disposal site, as compared to reference, has been negatively impacted by the dredging and disposal operations, a mitigation plan should be implemented. The anomolous fisheries results may be indicating that the underlying contaminated dredged material has not been isolated effectively, and the site may need to be reassessed relative to the contaminant isolation flowchart (Figure 9-3).

9.1.8 Description of Monitoring Techniques

This section provides brief descriptions of various surveying and sampling techniques commonly used to address marine environmental monitoring objectives and explains how each can be utilized to address specific questions associated with the disposal of dredged material in coastal embayments.

9.1.8.1 Disposal Tracking

Verification of the location and timing of dredged material or cap placement is a critical component of monitoring efforts. One approach involves the use of an automated vessel tracking system. Available systems provide fully automated tracking of disposal scow positions and draft level information using highly accurate differential GPS and pressure sensors during the loading, transit, and disposal phases of dredging operations. The disposal tracking equipment consists of an electronic box, battery, and antennas that can be easily installed onto one or more disposal scows. The instrumentation records the trackline of the scow navigation path, position of the released dredged material based on changes in vertical measurement of the scows position, and uplinks the data via ARGOS satellite for easy retrieval.

These data can then be automatically updated and displayed via the internet using a Geographic Information System. By recording the precise locations and timing of disposal positions when placing dredged and cap material, vessel tracking data can greatly increase the accuracy of cap material placement.

9.1.8.2 Sediment-Profile Imaging

Sediment-profile imaging is a benthic sampling technique in which a specialized camera is used to obtain vertical cross-section photographs (profiles) of the upper 15 to 20 cm of the seafloor. It is a reconnaissance survey technique used for rapid collection, interpretation and mapping of data on physical and biological seafloor characteristics; it has been employed in estuarine, coastal and deep-sea environments worldwide for almost 20 years. Measurements obtained from sediment-profile images are used to characterize sediment types, evaluate benthic habitat quality, map disturbance gradients, and follow ecosystem recovery after disturbance abatement. This technique was first introduced under the name REMOTS® (REmote Ecological Monitoring Of The Seafloor), a registered trademark of Science Applications International Corporation (SAIC). REMOTS® is a formal and standardized technique for sediment-profile imaging and analysis (Rhoads and Germano 1982; 1986). In generic terms, this sampling technique is called sediment-profile imaging (SPI) or sediment vertical profile imaging (SVPI).

The SPI hardware consists of a wedge-shaped optical prism having a camera (sensor) mounted horizontally above in a watertight housing. The prism is shaped like an inverted periscope, with a clear Plexiglas window and an internal mirror mounted at a 45° angle to reflect the image in the window up to the camera. The entire assembly is lowered to the bottom using a standard winch mounted aboard the survey vessel. Upon contact with the bottom, the prism descends slowly into the seabed, cuts a vertical cross-section profile of the upper 15 to 20 cm of the seabed, and a photo is taken. The camera normally is raised and lowered multiple times at each sampling station to obtain replicate images. Because the photographed sediment is directly in contact with the prism window and light is provided by an internal strobe, turbidity of the ambient seawater is never a limiting factor. Typically, 100 to 200 images can be obtained in a single survey day (i.e., three replicate images obtained at roughly 30 to 70 stations).

In the laboratory, a suite of physical and biological parameters are measured directly from the film negatives using a video digitizer and computer image analysis system. The measured parameters include sediment grain-size major mode and range, prism penetration depth (a relative measure of sediment shear strength), boundary roughness as measured from small-scale topographic relief (e.g., ripples, fecal mounds), depth of the apparent redox potential discontinuity (RPD), surface mud clast number and diameter, thickness of dredged material or other depositional layers, linear density of tubicolous fauna at the sediment-water interface, depth and number of subsurface feeding void structures, and designation of infaunal successional stage. Complete image analysis, interpretation, mapping and reporting can be accomplished within 1 to 4 weeks, depending on the size of the survey.

Sediment-profile imaging has proven to be an effective tool for addressing the monitoring objectives of several dredged material disposal projects (SAIC 1998). The information on physical sediment characteristics and biological activity has been useful for assessing benthic habitat quality both prior to and following disposal and capping operations. Sediment-profile imaging has also facilitated monitoring of the recolonization of capped dredged material mounds by benthic organisms following cap placement. In addition, sediment-profile imaging can be used to detect and map depositional layers of disposed project material occurring on the mound apron in layers too thin to be detected using high-resolution bathymetric techniques. For example, information on the disposal mound "footprint" was used to ensure that dioxin-contaminated dredged material was covered with clean capping material and thus isolated from the overlying water column at the New York Mud Dump Site (SAIC 1998).

9.1.8.3 Subbottom Profiling

Subbottom seismic profiling is a standard technique for determining changes in acoustic impedance below the sediment-water interface. In a seismic profiling survey, the vessel is driven over the seafloor along consecutive lanes in a manner similar to that used for bathymetric surveys. Penetration of sound in sediment is both a function of system frequency and the impedance contrast between the water column and sediment. In general, sound penetrates further into fine-grained sediment because the impedance of silt and clay with a high water content is closer to that of the water column. Sediments having different geotechnical characteristics (i.e. bulk density) will have distinct acoustic impedance, and therefore sound will reflect from the boundary between layers of sediment having different densities. The digital information collected via subbottom sampling can be used to identify depth to bedrock, and therefore potential containment capacity of a CAD cell, and for verifying the thickness and distribution of cap material in a CAD cell or on the open seafloor.

9.1.8.4 Geotechnical and Chemical Analysis of Sediment Cores

Geotechnical surveys are generally performed as part of a dredged material monitoring program to obtain sediment core samples at stations located on and around the disposal site. Vibracorer systems (which employ a motor to "vibrate" the core into the sediment) are used for sediment core analysis because they are capable of obtaining long, relatively undisturbed cores from coarser-grained sand caps, while conventional gravity corers (which rely on weight alone to push into the sediment) are incapable of penetrating to the desired depths. The cores provided a vertical section of both the sand cap and the underlying, fine-grained dredged material at a single location. Visual observations and geotechnical analyses of these vertical sections enable assessments to be made of sand cap thickness and stability through time, while chemical analyses enable a determination of cap effectiveness in isolating underlying contaminants.

9.1.8.5 Macrobenthic Analysis

Although the overall response of benthic infaunal populations to disposal activities can be assessed using sediment-profile imaging, ground-truthing of the images and more detailed information about benthic community structure including dominant species, diversity, and population density and abundance is primarily obtained through traditional benthic sampling and taxonomic identification of invertebrates. Grab samples are typically collected and analysed when assessing soft bottom infaunal communities.

Laboratory analysis consists of sample transfer to alcohol, Rose Bengal staining, and sorting to major taxonomic groups (e.g,. crustaceans, polychaetes, mollusks, nemerteans). Following initial sorting procedures, each organism is counted and identified to the lowest practical taxon (typically to the species level) by taxonomic specialists. Taxonomic data can be loaded into a database and evaluated using a variety of statistical procedures (e.g., Analysis of Variance and multivariate techniques such as principal component analysis and clustering) to quantify the relative similarity of benthic infaunal populations among the stations sampled. Summary information derived for each station from macrobenthic analyses may include estimates of: 1) mean number of individuals; 2) total number of individuals; 3) total number of taxa; 4) species diversity; 5) dominance; 6) species richness; and 7) species evenness.

9.1.8.6 Fisheries Assessment

A number of organizations have conducted assessments of seasonal fisheries distribution, abundance, and species composition in coastal Massachusetts using a variety of techniques and gear types, including boat trawls, beach seining, and diver transects. Shellfish resources have been mapped by delineating information provided by Commonwealth resource managers, digitizing data shown in the Massachusetts Monograph series, and interpreting video transect data.

Despite these efforts, continued monitoring is necessary to further define the pre-disposal (i.e., baseline) abundance of marine resources, estimate the magnitude and rate of reuse by non-benthic species, and assess the success of mitigation efforts. Effort is necessary to elucidate the relationship between physical conditions (i.e. sediment type, flow conditions, water quality) and marine resources at proposed disposal sites, to estimate the potential long-term consequences of permanent disturbance to the habitat from dredged material and cap material placement. This objective is best met by more intense but continued use of methods which have been successful to date such as diver transects and lobster early benthic phase suction sampling. Sampling techniques such as visual observations, benthic grabs, patent tonging, or raking can also be used to better estimate the presence and density of ecologically important bivalve species at disposal sites. This information should then be transcribed to cartographic products to provide a spatially-explicit record of shellfish and their abundance.

Post-capping sampling efforts are best addressed using a mixture of collection techniques for targeting demersal and pelagic species. These include use of otter trawls for capturing lobster and demersal species and experimental gill nets to sample pelagic fish species of various sizes. In waters less then 20 m, i*n situ* observation using video or 35 mm photographic images from a drop camera may also be utilized to estimate lobster size-class distributions or burrow densities. Shellfish colonization plates can be deployed at strategic positions in the water column to assess recruitment and attachment of larval forms of bivalves like blue mussels or eastern oysters. Further information about impacts (positive and negative) to commercial and recreational activities can be obtained from on-site interviews with local fishermen, bait shops, and resource managers, as well as conducting visual assessment of any commercial fishing activity and/or lobster pot distributions. Continuous contact with lobstermen and local fishing clubs or organizations can aid in identifying timeframes and locations of greatest activity, as well as provide a review of any proposed dredging "windows" (i.e. months in which dredging and disposal should be limited due to the presence of spawning or nursery activity).

9.2 AQUATIC DISPOSAL MANAGEMENT OPTIONS

As part the DMMP process, management examples within the state and throughout the country were investigated including the Cape Cod Disposal Site, NY/NJ Port Authority, and Barnstable County Dredge Program, to serve as potential models to be applied. The two most relevant approaches are discussed below.

9.2.1 State Managed Site

At the conclusion of the MEPA process and the designation of the Preferred Alternative, the state would own the site as Commonwealth Tidelands. Massachusetts Department of Environmental Management (DEM) would manage the operation of the aquatic disposal site in New Bedford/Fairhaven Harbor based upon a plan approved by MEPA and subject to recommendations of a technical advisory committee. This agency has a long history of managing state owned waterfront properties, such as state fish/cargo piers, and maintenance of waterways, including dredging state channels, harbors and berthing areas.

As the disposal site manager, DEM would officially obtain site designation by securing permits from DEP and USACE; announce the availability of the disposal site to public and private users; levy any fees for use; have legal authority to manage liability; oversee disposal activities; and monitor short and long term impacts and environmental conditions of the disposal site environs. DEM would also publish operating specifications to ensure that contractors meet disposal and capping specifications.

9.2.2 City/Town Managed Site

To establish a City managed site, an application would be filed by the City to use the disposal site designated by the MEPA process. The City managed site would be subject to a MEPA approved management plan. The City would license the facility under Chapter 91, assuming all management responsibilities. The City would be responsible for permit compliance, legal agreements with contractors using the sites, establishing disposal rates long-term monitoring and remediation if necessary.

Under this option, an agency of the City of New Bedford and/or Town of Fairhaven, or an existing or created semi-public authority would manage the disposal site. The agency would levy fees for use and manage liability much like that of a municipal landfill. The City would establish a revolving or enterprise fund to manage the long-term operation of the facility. New Bedford and/or Fairhaven would be responsible for program implementation, operation, and monitoring.

9.3 SUMMARY

CZM will develop, implement and monitor a detailed Disposal Site Management Plan for the final preferred alternative pursued in the FEIR. This plan will identify the site specific measures necessary to minimize potential negative impacts to the environment associated with implementing the final preferred alternative. The plan will include the monitoring measures discussed in this section. The plan will also establish the environmental baseline upon which performance of the site will be gauged. The Disposal Site Management Plan will also include triggers for appropriate actions to be taken if criteria are exceeded.